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Vol. XXVII. Part III. SEPTEMBER, 1956.

THE

TEA QUARTERLY

THE JOURNAL

OF THE

TEA RESEARCH INSTITUTE

OF CEYLON

THE TEA RESEARCH INSTITUTE,
St. Coombs, Talawakelle,
Ceylon.

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THE TEA QUARTERLY

VOLUME XXVII SEPTEMBER, 1956 PART III

OPENING ADDRESS TO THE PLANT PROTECTION SECOND INTERNATIONAL CONFERENCE

Sir Frank Engledow, C.M.G., F.R.S.

The following address, which is reproduced by kind permission of the author and of Plant Protection Ltd., opened the Second International Conference on problems of crop protection, which was held at Fernhurst Research Station in June, 1956. This general survey of all aspects of crop protection by an eminent authority will undoubtedly greatly assist all those engaged in this type of work in viewing it in its correct perspective.

Control over crop disorders and damages has been much enlarged by knowledge gained in the past decade. Many crops and countries have benefited, and for the general expectation of even greater progress in the early future there are firm grounds. Not all the new knowledge is to our comfort, however, for disquiet about certain forms of control has become decidedly stronger. Both scientifically and practically, nevertheless, the general prospect is a cheering one. It is much enhanced by the development, now well marked, of a combination in thought and in experimentation on crop protection among the relevant sciences and between science and husbandry.

Costs of protection are running high with some crops, and satisfactory procedures and field equipment are not yet available for others. In asking for improved appliances, the practical man is unlikely to realise the difficulties met in making drops of desired sizes and causing them to move in variously desired ways. The session on producing sprays will, therefore, be welcome, notwithstanding the scientific complexities of the subject.

Agriculturists are content to wait for a steady cheapening and improvement of equipment, and their true disquiet is mainly over two familiar phenomena which look more ugly every year. In checking one pest by chemical means another may be encouraged. The likelihood of this may be unpredictable and only discoverable at the grower's cost. Secondly, there are the cases of swift invasion by formerly unimportant fungus strains in a new crop variety bred to withstand the strain formerly prevalent. The general public, too, is becoming watchful in the matter of plant protection of a possible new aspect of what we have come to call "chemicals in food". This is a very proper concern, though liable to be reprehensibly turned into a confused alarm. To discover underlying principles in all these disquieting issues is the most urgent task in crop protection.

Crop protection practice, particularly chemical methods, is closely pursuing—and at times outrunning—new knowledge which itself is moving fast. A pause is needed for contemplation—contemplation of current practice, of the adequacy of basic knowledge and of the objectives in research. That is why this Second International Conference has been arranged four years after the first. Though its sessions must be limited to but a few topics, its purpose implies a wide outlook, for it is the

task of crop protection to provide controls over all organisms harmful to yield or to quality in every kind of plant useful to man.

The enemy organisms are many times more numerous in kind than the crops they attack. Some of the groups with which this Conference has no concern seem to the agriculturist to need much more attention. Mammals, especially rodents, may be instanced, but birds seem especially neglected. Pigeons in Britain and the beautiful but obnoxious *Queleas*, the Weaver bird, in several parts of Africa signify the seriousness of the avian menace. Neglect of the matter is illustrated by the fact that governments in the African continent have not even begun to unite in surveying the big game, and some of the birds which are known to be concerned in some of the gravest diseases of livestock or in crop damage. Disparate territorial investigations have very limited merits.

Even the insects and fungi harmful to crops have, as yet, only been studied scientifically and tackled practically in piecemeal fashion. Ups and downs in crop loss from pests and diseases have continually distracted research, especially in the tropics where staffs are small. Any big outbreak must be promptly attended to, and records of plant pathology and entomology are heavily marked by unfinished investigations. It might be well and practicable to single out the chief groups and to ensure continuing study on these, unimpeded by currently important outbreaks. This would require not only greater resources for research but, more importantly, a wider conviction among responsible authorities that progress in crop protection must be built on full knowledge of the agents of damage.

It is necessary to bear in mind that there are, at this Conference, not only physical and biological scientists—the initiators of protective methods—but also those who supply advice, materials, equipment and contract services. The growers, however, must take the central place in our concern. They are the first to encounter the trouble, and it is they who pay in money and toil for the protective measures. Some observations from their side will therefore now be made.

In conferences, lectures, text books, control of pests and diseases by certain husbandry practices is enjoined almost rubrically. But what is firmly known of its possibilities? Is there a danger that the specialist in whose province this lies may not give it sufficient experimental attention but may rather wait for the chemist to make husbandry control no longer worth attempting? Agriculturists have increasingly disciplined their traditional beliefs and practices by well designed field experiments. Naturally, then, they ask for rigorous trials of all crop protection substances, the issues being as follows:—the best amount, method and time of application; resulting effects on yield and quality; cost; behaviour of different varieties; locality variations and effectiveness; and, interactions with husbandry practice and, of course, effect on other organisms.

It would be hard to find a more appropriate place than Fernhurst for a critical discussion on the design and execution of field trials. A period of practical use, as well as trials, is always necessary for full answers, but trials fail unless they give ample preliminary guidance on all these issues. In the difficult matter of designing and carrying out these trials, expert opinion seems not always clear nor harmonious. Large numbers of small plots, for instance, allow easy movement of mobile organisms from plot to plot. Small numbers of large plots are statistically unsatisfactory, and large numbers of large plots involve great heterogeneity of soil. How, then, is the best design to be decided upon in any particular case? The trial might be in the midst of a large unsprayed area or in the midst of a large sprayed area; or perhaps there ought to be a trial in the midst of one of each such areas. Which is the better?

There are numerous secondary problems as well; for instance, how to treat plots when testing a substance which is to be applied from the air. It would gratify

agriculturists and do no harm to experts if these questions could be fully argued for a few cases of both large scale and small scale production—let us say, cotton pests or banana diseases. Agriculturists are by no means satisfied with the evidence for the claims made for some protective substances nor at the very early stage at which some of them have been offered for general use. Everyone accepts the necessity for devising more reliable trials for insecticides and fungicides, but who will take action? This matter, though of primary practical consequence, is not one for primary research. Manufacturers may perhaps feel a greater responsibility in it than they have so far exercised: certainly it would be in their long interest if a decisive system of trials were devised and regularly used.

Year-to-year fluctuations in severity of pests and diseases are well known. It is for specialists to judge whether sufficient research is in progress on the nature of these fluctuations and their relations to physical environment. With fuller knowledge it might be possible to predict the likelihood of some attack at any period of the year from the preceding weather data. Omission or reduction of treatments could sometimes then be practised. Place-to-place differences in treatment results in the same year are also known. Jassids on cotton, black pod on cacao and the onion fly are puzzling examples of this, but presumably the phenomenon is connected with the degree of mobility and method of propagation of the organisms and also with localised differences in physical environment.

Existing knowledge about all this is not, however, of much serious practical value. More experimentation under controlled environments, though difficult, seems to be necessary. More ample local repetition of field trials would certainly be helpful; also, if the local experiences of contract spraying were collated every year, suggestive indications might emerge.

Very large continuous areas of the same crop, especially if all of one variety, have been suggested to be pathologically unwise, particularly with perennial crops. This suggestion still remains to be developed into practical recommendations. Organised protection for recognised crop production districts has not yet become at all widely developed. It is familiar, of course, in the close season in some cotton growing areas and in the regulations sometimes made about alternative host plants. The method, however, has many different applications, and seems to merit much further thought.

Agriculturists have strong reasons for concern about those pests and diseases which harbour in the soil. Chemical treatment of only the top seven or eight inches involves about a thousand tons of soil an acre, and harmful plant nematodes, for instance, are found to three times that depth. It is true, for instance, that wireworm, flea beetle and carrot fly may be dealt with effectively by seed treatment; it is when the soil in masses has to be treated that the agriculturists' concern arises. What good or harm may be done by a soil treatment to other than the destined organism is at present purely a matter of guessing. Some indiscriminate destruction of organisms certainly occurs and may eventually favour the agriculturally undesirable forms against which the chemical treatment is applied, or it may favour some quite other undesirable.

Now, fear of cumulative effects from long continuations of certain husbandry practices or from repeated chemical treatment of soils is very widespread among farmers. That, of course, does not refer to the use of chemical fertilisers. The consequence might be far more serious than the occasional loss of even a whole crop for one year.

Now, a final reason for this concern about treatment of the soil relates to crop rotation. Traditionally, this practice of crop rotation is reckoned to assist the economic balance of the farm working, to enable labour to be spread through the year, to

look after the maintenance of soil fertility, the control of weeds, and to avoid the accumulation of soil-harbouring diseases and pests. Various developments in the present century have, in the judgment of very many farmers, taken the force out of all these considerations except the last—that is, crop rotation as a necessary means of preserving the soil from soil-harbouring diseases and pests. Thus, the far greater freedom which may now be used with crop rotation appears to be chiefly limited by the fear of certain soil pests and diseases. The types, numbers and activities of soil arthropods and micro-flora must be amongst the most elusive subjects in the joint field of chemistry and biology. Whilst these matters remain obscure, fears about unpredictable damage through soil treatments are bound to persist. In the agricultural view these organisms should have much more attention and some responsibility for providing this lies with those who concoct and use crop protection and weed control substances. It is therefore particularly gratifying to us on the agricultural side to see that the hazards of various kinds from crop protective substances have a whole session at this Conference.

Because chemists have sometimes been too bold, or farmers too credulous, certain protective substances have been offered for general use without sufficient trial and later withdrawn. Remembering the past confusion caused by similar impetuousness in connection with new varieties of crops, it is to be hoped that all concerned will insist on adequate testing. Farmers have the power to check this irresponsible marketing, if they care to use it, and they have also for their guidance an official approved list of crop protection substances.* Another consequence of new protective substances being frequently issued after only a brief trial is that the farmers' advisers, feeling obliged to make thier own tests, are unduly withdrawn from their normal work. It is now not uncommon for a trained entomologist or plant pathologist to spend most of his time testing proprietory substances. This diversion from fundamental work is most regrettable.

Increasing use of chemical methods has independently confirmed the conviction that progress in crop protection depends on advance in basic knowledge of the harmful organisms. Study of these organisms must now include the organism itself and the reaction to treatment and also the nature of the interaction between organism and host plant. In this urgently needed work both plant physiology and biochemistry are involved. Plant reaction bears also on the genic resistance to disease, and is therefore of interest to plant breeders. It is, indeed, one of the matters in crop protection requiring union among several branches of science. Routine trials, should not be allowed to prevent scientists taking their part in this united work, especially the pathologists and entomologists. We at this Conference, at any rate, will not be left unaware of the complexities of reactions between aggressive organisms and the protective substances. Papers dealing with this and with systemic protectives will not only set out difficulties yet to be solved, but will be able to record some notable achievements.

Most of the agricultural holdings in the world are small. The food of a large portion of its population is grown on tiny patches of land. Europe has many small farming units. In the tropics, where they predominate, they are often diminutive and range from intensive rice growing to the lower output of the shifting cultivator. They obstruct every protective movement, for, besides the inconvenience of smallness, there are ignorance and prejudice, superstition, and poverty of resources.

The needs of these tiny producers should not be forgotten by the manufacturers of crop protective substances and equipment. Crop protective substances are now being energetically marketed in most tropical territories. The extreme sparseness of knowledge of the insect population of these territories lays this venturesomeness

* Crop Protection Products Approval Scheme. Approval List: 1956. Published by the Ministry of Agriculture, Fisheries and Food, United Kingdom.

open to grave risks. It is in these territories also, especially where yields are characteristically low, that over insistence on the benefits of crop protection may lead to neglect of husbandry improvements. Take the case of cotton in some parts of East and West Africa. Early sowings, unsprayed, yield, in spite of insect damage, better than late sowings with repeated sprayings. Now, early sowings and also spraying would have been the right course, but the former—the early sowing—is the first thing to encourage.

Farmers, with scientists, look forward to new substances and methods for crop protection. History is long enough with some crops to make it worthwhile to look backward as well. Insect populations in apple orchards, harmful and beneficial alike, seem to have shown a steady compositional change, probably not unconnected with the change in chemical protectives used; and with, though not necessarily entirely through, these changes total costs of protection have steadily gone up. Must these changes go on unchecked and undirected, the effects of each protective regime being so to change the insect population that a new set of protections is made necessary, and so on and on? All concerned must obviously accept, what is now axiomatic among entomologists, that the entire insect population of a crop—indeed, the locality in which the crop is situated—must be studied. To study and apply protection against obnoxious organisms one at a time, as in the past, is liable to create a new problem everytime an old one is solved. Hopes that protection from disease would eventually be provided in full by resistant varieties have become tempered by proof of the abundance and capacity for rapid spread of biologic strains in many fungal groups. But against this may be set the new resources supplied to breeders by cytogenetics—the power to move genes not only among nearly related forms but among widely related also. It is necessary to ask how this ability and other resources compare with the genetic and breeding work on resistant varieties. That greater resources should be given to the one than to the other must not be assumed, for their claims depend upon the probability of success. The Conference will listen with close attention to the authoritative assessment of the prospects of protection by plant breeding which is to occupy one of its sessions.

The diversity of physical and other circumstances of crop production in the various world climatic regions, the dependence of practical progress in protection upon basic knowledge of inimical organisms and of host plants, and the essentiality and scope for concert among the sciences are the things which seem, from the agricultural point of view, to make up the environment of thought on crop protection.

Chemical control of pests and diseases is now coming into university teaching. In agricultural courses it is essential, its substance there being practical uses with simple explanations of chemical and biological aspects. If more advanced teaching were to be considered, the initial question would be how much scientific knowledge specific to or primarily arising from or concerned with chemical control is available. A body of practical, factual knowledge, even if much greater than that now available, would be no foundation for an advanced university course. For deeper scientific understanding of control, more knowledge of insect physiology and its chemical responses, of insect reproduction and population 'phenomena and of insect-host relationship is indispensable, with an analogous requirement for diseases. There is not likely to be, for a long time, enough primary knowledge and basic principles in these fields to constitute a subject of advanced teaching. Well trained entomologists and mycologists, strong, also, in chemistry, and good chemists suitably knowledgeable in biology are the best material for basic and applied research in chemical control. The normal honours courses can provide them and they will be attracted to chemical control in measure as this subject moves from empiricism on to firm scientific foundations.

IDEAS ON THE EXPERIMENTAL REPLANTING OF TEA

J. A. H. Tolhurst

Replanting of old tea is a subject which will command ever increasing attention, and this article is an attempt to summarise the Institute's findings to date, and to give a guide for future replantings. An address given to the Nuwara Eliya District Planters' Association was used, at their request, as the basis of the article, and we have taken the opportunity of including points raised at the Experimental Committee meetings and in private discussions with superintendents. The emphasis here is naturally on soil conditions, and for these ideas the author takes responsibility, while acting as spokesman on other matters.

Replanting on St. Coombs.—First, what replantings have been done by the Institute and with what results?

In 1952, two acres in No. 10 field were replanted with ten different clones, and in 1952 a start was made on nineteen acres in No. 1 field using more or less the same clones, and by the end of 1955, eight acres had actually been planted. The No. 10 area has been a definite success, and the No. 1 area has been, just as definitely, a failure.

It is not pleasant to have to record a failure, but it should be remembered that in our search for sound agricultural practices we are bound to come across those which are not so acceptable. It is, indeed, preferable that a Research Institute should be the first to meet them, on a small scale, thereby preventing their perpetration on a much larger scale. In 1952, and even in 1956, replanting of old tea was a highly empirical agricultural operation with the inevitable risks, and we should be glad to have the opportunity of trying to explain the failures and of planning future experimental replantings on a surer basis. We will compare the conditions in the two fields, as far as is relevant, before drawing conclusions for suggestions for general methods of replanting.

Soil conditions in the St. Coombs replanted areas.—No. 10 field was opened from rich patana in 1931, while No. 1 field was opened from jungle in the 1880's. No. 10 lies on a moderate north-east slope in a sheltered valley with an annual rainfall of 80-90 inches, while No. 1 is on a steep to very steep south-west slope at the highest and most exposed point for several miles, and where the rainfall is known to be less than it is in the No. 10 area.

Even a cursory examination of the two soils shows that they are not similar, and chemical analyses done in 1955 bear this out.

Table 1. *Analyses of soils in Nos.* 1 *and* 10 *fields, St. Coombs.*

	No. 10		No. 1	
	Top soil	Sub-soil	Top soil	Sub-soil
% Organic matter	9.2	6.4	4.8	2.8
% Nitrogen	0.35	0.23	0.23	0.17
Depth	0-6″	6-12″	0-6″	6-12″

Further detailed analyses on a wide range of soils, done in 1955 and 1956, all point to the fact that the breakdown of organic matter is accelerated to a remarkable degree either by aerating the soil or by alternately wetting and drying it. This chemical knowledge will be emphasised subsequently, and it is unfortunate that it was not available before the two clearings were started.

It has been established for several years, in many other countries, that if fresh green organic material is turned into the soil, the soil microbes are stimulated to such an extent that they decompose the new addition very rapidly and they may even continue, under their own momentum, to break down some of the original soil humus which had previously resisted their attack. The net result has sometimes been that digging in fresh organic material has led to an overall decrease in soil humus, and with our knowledge of microbial liveliness in Ceylon tea soils we may assume that a similar state may hold good here.

To return to the two fields which were planted in Guatemala grass after the tea had been removed. In the first place the uprooting process aerated the soil, and secondly, an even greater disturbance was imposed by the digging of an one-foot wide trench on the line of the future tea row. The loppings from the Guatemala grass were put into the trench and covered by a little soil pulled in from the original spoil from the trenches. While the grass was growing the soil was very largely exposed to alternate wetting and drying; as soon as the grass had formed a reasonable soil cover it was cut, soil was disturbed, and fresh areas of soil were subjected to the next cycle of exposure. Manure for the grass was forked along the grass rows and the trenches were left with a mixture of loose soil and fresh grass loppings. At the final cutting, when the grass was removed entirely, the trenches were filled in and left for six months. Presumably if the level sank in that time more soil would be cut from above.

It is easy to be wise after the event, but it is difficult to see how these energetic operations could have done anything but decrease the soil humus, lower the water retaining capacity and increase the danger of erosion, which may be considerable if soil is repeatedly dried and disturbed on steep slopes. An added disadvantage would arise if the trenches were topped up with some of the original subsoil. Yet another danger, and a very real one if the labour were unreliable, would be that the final consolidation of the trenches may be insufficient, leaving the young plants in loose soil, very prone to drying out, and continually sinking. If the sinking were to go far enough there would be a danger of water standing round the stems of the young plants, on what would then be consolidated soil.

Applying these remarks to the two areas on St. Coombs we can begin to explain why one succeeded and the other failed. The successful No. 10 clearing was planted on rich firm soil which was able to stand the drain on its reserves of humus, and which may well have benefited from the enforced aeration. The subsoil here was quite rich in itself and extended to a good depth. There was not the same rate of loss of water as would be expected from a steep, exposed site.

The No. 1 area was planted on soil which had suffered from a far longer period of cultivation, and which, judging by analyses of nearby jungle, had never had such quantities or depth of humus as the No. 10 patana soil. The No. 1 soil was already low in organic matter and very liable to go powdery when dry, so that any further steps in this direction would be detrimental. Add to this the previous comments on loss of water, both by drainage and by wind action, and it will be seen that differences in behaviour might be expected, even with identical planting methods.

Transplanting.—So far the method of planting and the plants themselves have not been mentioned, but both these factors helped to accentuate the differences between the two fields, and both are intimately tied up with soil conditions.

The earlier field under the better soil conditions, was planted up with plants removed straight from the propagation beds, in Hersall transplanters, and there was both selection of good plants from the nursery and close supervision of the planting in the field, by the Institute's field assistants. The larger No. 1 field made use of balled plants, and the greater demand on plants meant that no selection was possible. Also, as this was entirely a St. Coombs estate operation, the immediate supervision was not of such a high standard.

Transplanting of woody plants has long been regarded as a tricky operation, by that class of horticulturalist which has been designated by the expression "green fingers", and there is every reason to believe that tea plants need just as much care as any others. It is also recognised that any set back incurred in the early stages of a perennial plant's life will almost certainly stunt growth for many years after. This is not the place to go into details, but the Plant Physiology Department has for many years advocated the use of well fed, selected basket plants for the planting of clonal areas, on the grounds that replanting is such an expensive operation, that it is a pity to "spoil the ship for a ha'porth of tar".

A basket plant carries its food reserves into the field with it, and the young, weak, roots are able to grow out into the surrounding field soil as they find conditions favourable. A balled plant carries less reserves and the young roots are often damaged seriously, and there is little protection afforded if the field conditions are bad. A basket offers a guide to planting depth, and from our own observations, ranging from roots sticking up out of the soil like an inverted umbrella to plants buried up to the second branch, it is not always wise to trust the average labourer to handle balled plants properly.

A young plant trying to establish itself after moving into the field has to draw on its internal food reserves to promote the development of the root system, which will eventually support the whole of the plant's food manufacturing processes. The easier it is for the roots to grow rapidly, the quicker the plant will respond. Young roots are favoured by well aerated, moist soil, that is open enough to permit easy physical penetration and close enough to ensure that the roots can keep in contact with water reserves throughout their wanderings. With the right combination of air and water supply roots can grow most vigorously and also extract mineral nutrients from the soil and manure most efficiently.

Many replantings will, naturally, be done on the areas with bad soil conditions, and it is with these in mind that we suggest a method for improving old cultivated soil and which we think will avoid some of the drawbacks of the previous trenching method.

Soil rehabilitation.—There are various reasons why the Institute has recommended an interval under another crop before replanting with tea, and one of these aspects, concerning root diseases, has already been dealt with by the Pathologist in the 1955 Conference report. Another aspect is biochemical in nature, as far as we know, and although it is not proven in tea growing it is well known with many other woody perennials. When such a plant is pulled out of the soil there is usually a toxic effect noticeable on young plants of the same species if they are planted immediately afterwards.

Our opinion is that grasses are the most useful crop for rehabilitation, from all aspects, and for ease of planting and of the final removal we recommend those with tussocky growth, such as Guatemala, manna, and napier. Adaptability to conditions in a particular locality will govern which of these species is used, its planting distance, frequency of cutting, etc.

Grass roots in general have a marked effect on the soil, in that the latter falls into quite stable crumbs which resist disintegration under rainfall or mechanical action, such as walking or cultivation. The longer the period in which the soil is under grass the more numerous and stable are these crumbs, and it is their properties which are likely to be of such value in bringing old soil into a fit condition for young tea. The body of a soil rich in stable crumbs will be well drained and aerated and will offer little resistance to young roots, and at the same time the individual crumbs are able to hold reserves of water. Such a soil can be trampled without becoming packed too closely, and firm contact between the soil crumbs merely forms a continuous net-work of moist soil surrounding the air channels. This action of the grass roots takes place during the life of the grass, and as soon as the grass plant is killed the roots begin to decay. An individual plant of one of the large grass species can produce several miles of roots, which penetrate the soil extensively and to considerable depth. As these roots decay they leave well marked drainage channels behind them.

Apart from these physical effects of grass roots there are important chemical actions, which again apply to grasses in general. Their roots have a good foraging ability for potash and phosphate, and they can often make use of resistant forms of these nutrients which other plant species are unable to break down. When the grass dies, these hard won food reserves are released slowly to the soil in more available forms, both from the roots and the leaves, and other plants are then able to make use of them.

Finally, the effect of the above-ground part of the grass. If the setts are planted closely there will be a very good protection of the soil from sun and rain, and as soon as the first loppings are spread on the surface this protection will be as good as can be desired. If each lopping is spread on the soil, with no digging in, any undesired microbial activity resulting from cultivation and exposure will be avoided. The lower layers of the thatch will, under protection from the newer, upper layers, decompose very slowly and will gradually permeate the soil as stable humus. We must again emphasise that we consider thatching to be the best method of increasing the humus content of a soil, and that forking organic residues in is likely to result only in excessive microbial activity for a short period. This activity in itself may be desirable at certain times, but not, we suggest, during this period of rehabilitation.

Manuring.—If we are going to rely on Guatemala grass to do so much work in reconditioning and protecting the soil, we should help it by manuring generously. Not only will this increase the production of organic matter, but it will also ensure that the Guatemala does not leave the soil starved of nutrients, and as the grass is a gross feeder this could easily happen.

In all probability broadcasting the manure on top of the thatch would be sufficient, but light forking may be done if it is thought necessary. Such a forking would not bring about the excessive stimulation of the microbes which we are trying to avoid. Some of the manure will become incorporated with the thatch, and this will prove of value later on, but sufficient manure will certainly wash down into the soil to reach the Guatemala roots. Our recommendations on manuring Guatemala grass will be found in the *Tea Quarterly*, March/June, 1956.

A most important point is that when the Guatemala grass is finally cut out, ready for the planting of the tea, the area should again have a broadcast manuring. The reason for this will be explained in the next section, but here we would suggest that this application could be from 3 to 4 cwts. per acre of the Guatemala mixture, and we must also emphasise that generous manuring over the whole of the rehabilitation period will more than pay for itself in terms of rapid establishment of the tea.

Soil activation.—So far we have been suggesting ways of repairing the damage done to the soil by past cultivation, of building up the reserves or organic matter

and mineral nutrients, and, above all of keeping the soil microbes healthy but not too active. All these aims, we believe, can be achieved by planting one of the large grasses closely, by manuring it well, and by cutting the tops and leaving them on the surface with no further soil disturbance.

When the time comes to plant the young tea we have to reverse these processes whether we like it or not. The cutting out of the grass stumps and the holing for the tea automatically stimulate the microbes. After two years' accumulation of organic residues there should be plenty to spare for both microbes and tea, and the recent incorporation of the manure into the soil and the thatch will guard against competition for the mineral nutrients. Microbes are most efficient and voracious feeders, and they can multiply so rapidly that they could readily starve a young, weak, tea plant unless there were ample food reserves in the soil.

The dying grass roots will also be attacked by microbes, again drawing on reserves of mineral nutrients to assist their action, and the reason for the final manurial application, mentioned in the preceding section, is obvious.

When holes are cut there will be a fall-in of the lower, well decomposed, layers of thatch. This should be encouraged, as it will not hold the soil too open, and will carry a good reserve of absorbed inorganic manure with it. These rich organic residues, releasing nutrients slowly but steadily to the tea roots, are the best possible form of manure for young plants which grow rapidly and which have not yet been able to establish a good foraging root system. They also retain a high proportion of moisture.

The preceding discussion has, we hope, given the reasoning behind the Institute's suggestions for replanting, which are best summarised in the table on the opposite page.

Conclusions.—In the table it is suggested that the grass stumps may be useful as wind breaks. This is not so unlikely as it may appear, since it is well known that even small objects on the soil surface can deflect wind considerably. As the tea will be most susceptible to wind when it is first planted out, when it will not be tall, we suggest that the large number of stumps available might give valuable protection.

The table does not pretend to be a guide to all the operations involved in replanting, and one important factor has been left out, that of the shade tree programme. Shade and wind break plantings can only be settled by the demands of the particular environment and by the personal preference of the superintendent. An obvious danger to avoid is undue competition for water and nutrients between the shade and the tea, and for this reason we unhesitatingly condemn the idea of leaving any of the grass growing after the tea is planted. The author has a personal liking for *Sesbania aegyptiaca*, which is both easy to establish and easy to remove without damage to the tea, is rapid in growth, and which has an open head capable of giving a diffuse shade and a reasonable check to wind. The sparse foliage seems to be an advantage, in that the drain on soil moisture is almost certainly low.

We hope that these suggestions will afford a reasonable basis on which we can plan a practicable method of replanting old tea, and we have gone into the historical and theoretical reasons for our change of policy at some length because we want to show that we are not making this change lightheartedly. We feel that we have sufficient evidence, from field plantings and from laboratory analyses, to warrant the modification.

Table 2. *Proposed system of soil rehabilitation and replanting of tea*

Period	Operation	Intention
Soil rehabilitation	1. Following uprooting and contour lining plant thickly with grass, preferably 2 rows between the future tea rows.	1. Maximum soil cover; minimum soil disturbance.
	2. Manure regularly with little or no forking.	2. Maximum production of organic matter above and below ground; building up mineral nutrient reserves.
	3. Cut regularly and spread loppings all over surface.	3. Protection of soil from sun, rain, wind and packing by labourers' feet.
	4. Continue for preferably 2 years.	4. Disease control; build up of stable soil crumb structure.
Soil activation	1. Cut grass right out.	1.
	2. Leave grass stumps whole on the surface.	2. Wind break for young tea (see conclusions).
	3. Broadcast manure.	3. To assist the increased microbial activity from 1 and 4.
	4. Hole, incorporating old thatch in the holes.	4. To provide steady supply of nutrients to the young tea.
Planting	Use selected, well fed, basket plants; plant firmly and shade if necessary.	

Our new proposal is really very simple, and it can be described as an attempt to get back to jungle conditions, but for convenience and greater efficiency we have aimed at a grass jungle. The original tea plantings made use of fertility which had accumulated over the centuries, and which had often vanished alarmingly once cultivation had imposed new and exacting conditions on the soil. We can not hope to regain more than a small part of the virgin fertility in a rehabilitation period which, from economic necessity, can only last for one or two years, but as the object of replanting is to grow better tea, and as the future of the planting will depend so much on the initial success of the clearing, the Institute can not stress too strongly the need to implement all the proposals, set out above, in the most generous fashion.

SOME THOUGHTS ON FORKING

G. B. Portsmouth

There are many different ways of using a fork and it must therefore be made clear at the outset that the only type of forking which will be dealt with in this article is that generally known throughout Ceylon as "deep" forking. Neither "light" forking nor the type of forking adopted by most gardeners, in which clods of soil are actually turned over, will be considered.

The operation of deep forking is one in which a fork with three or four tines, 15 to 18 inches long, is forced into the ground at a nearly vertical angle as far as it will go, or can be pushed without undue effort by the labourer's foot. The handle is then pushed forward so as to open up a crack in the soil behind the tines. The fork is then either withdrawn, when the operation is called "plain" forking, or else something is pushed into the open crack with the foot prior to withdrawal of the fork. In this case the operation is called "envelope" forking and may be used in the application of mineral fertilisers or else to incorporate ground litter, green manure loppings and similar materials into the soil. Diagrams showing the correct and incorrect ways of doing deep forking are given on page 25 of the *Tea Quarterly* for March, 1950.

Having now defined what is meant by deep forking it will be helpful to try and assess what effects this operation is likely to have on the soil itself. Incorrect forking will undoubtedly also cause much damage to the roots of the tea bush, but if the operation is carried out correctly, according to Paterson's recommendations [1] there should be very little root damage and this effect will accordingly be disregarded in the ensuing discussion.

Now the first and most obvious effect of forking is to open up the soil. This will increase aeration down to the lowest levels penetrated by the fork tines and will also increase the absorption of surface water. Conversely, in periods of drought it will also greatly increase the rate of loss of soil moisture and so accelerate the drying out of the upper soil levels. Further, during showery weather the effects of alternate wetting and drying will be intensified. These effects are important, since, as pointed out by Tolhurst in another article in this issue [2] they lead to a remarkable acceleration in the rate of breakdown of soil organic matter.

Finally the mechanical disturbance caused by forking will tend to have a deleterious effect on the crumb structure of the soil, if it has any to start with. This in turn will, if not counteracted, lead in time to a greater tendency to pack down readily, impeded drainage and aeration and reduction in water holding capacity.

The effects of forking, either "plain" or "envelope", in which the addition of mineral fertilisers and/or organic materials produces still further complications, are thus seen to be most complex and even contradictory. This, however, should not cause undue surprise if, as is common practice nowadays, the soil itself is thought of as a complex organism in which physical, chemical and microbial activities are all interacting at one and the same time. From this viewpoint therefore it is easy to see that any disturbance of the existing dynamic equilibrium is likely to have far reaching and largely unpredictable effects. Furthermore, no two areas of soil, even though indistinguishable on physical or chemical grounds, can be expected to have the same microbial population and so may well react entirely differently to any disturbing factor such as deep forking.

Unless therefore a great deal is known about the soil conditions, the nature of the ground cover and the prevailing climatic conditions, it would seem to be practically impossible to forecast whether the deep forking of any particular area is likely to prove beneficial or harmful. No hard and fast rules as to when to fork and when not to fork can accordingly be laid down for the guidance of superintendents. The best that can be done is to quote a number of specific examples of different soil categories and to try and decide as to whether forking is advantageous or undesirable in each case.

Category 1.—Soils with a high level of fertility and good crumb structure.—These soils will have good drainage and aeration and a high level of microbial activity. Their content of relatively stable organic matter is also likely to be high.

Forking of this type of soil in showery weather, which is the only time when forking ought to be carried out at all, will enhance the effects of alternate wetting and drying, thus greatly stimulating the already intense microbial activity. This in turn will lead to a more rapid breakdown of the soil organic matter. The addition of green manure behind the fork will still further stimulate this activity leading to increased losses of organic matter and to the temporary locking up of mineral nutrients, which are thus rendered unavailable to the tea bushes. These effects are clearly undesirable.

Since the soil is already well drained and aerated, forking will bring about no improvement in these characteristics, while the mechanical disturbance will have a deleterious effect on the existing crumb structure. This will again deteriorate still further due to the loss of some of the organic matter binding the soil particles into crumbs which will occur as a consequence of the increased microbial activity referred to above.

The organic matter content of this type of soil can probably be only built up by addition of organic material in an already highly stabilised form. Such material is normally only produced in conditions where a good mulch has been built up on the surface of the soil, either as the result of thatching with Guatemala grass or similar loppings or from natural leaf-fall under a complete cover of tea and overhead shade. An occasional deep forking, such as once in a cycle, might thus be of some value in bringing some of the stabilised organic matter formed in the surface mulch down into the deeper soil levels.

With a good surface mulch most of the feeding root activity will be concentrated in the upper soil levels. Application of mineral fertiliser by deep envelope forking will therefore tend to put it into soil levels which are below the zone of maximum feeding root activity and should be avoided. Broadcasting or scuffling in of fertiliser is clearly preferable.

The above discussion would appear to fully support the opinion expressed at the 1953 Conference to the effect that "*under a good cover of tea and probably only under a good cover of tea with a certain amount of mulch under the bushes*, too much deep forking is not only unnecessary but definitely harmful" [3] since, in old tea, it is only where the italicised conditions exist that the soil is likely to exhibit a high level of fertility.

Category 2. Soils with a medium level of fertility and poor crumb structure.—This is a type of soil likely to be found in parts of Uva and the mid-country especially. It may tend to pack down on the surface, with consequent heavy run-off of surface water. The cover of the tea may be incomplete, leading to soil exposure and there will be no surface mulch. Both the organic matter content and the level of microbial activity are unlikely to be high.

Forking of this type of soil in showery weather will break up the hard surface and greatly improve both the aeration and water absorbing capacity. This latter effect is of considerable importance in districts such as Uva, which are subject to prolonged periods of drought. Furthermore since it may well be desirable to raise both the organic matter content and the level of microbial activity the forking in of undecomposed green material may prove beneficial. However, since the resultant increase in microbial activity will also cause a temporary locking up of available mineral nutrients, it would be sound practice only to fork in green material at the same time as mineral fertiliser is applied. Both can be safely applied by envelope forking, since it can be reasonably expected that the zone of maximum feeding root activity will be at a deeper level than in the case of category 1 soils.

Mechanical disturbance from forking will, of course, tend to destroy the existing crumb structure, but this effect is likely to be more than offset by the improvement brought about by raising the organic matter level. In general therefore the regular deep forking of this type of soil would appear to be beneficial.

Category 3. Deteriorated soils with low fertility and little or no crumb structure.—These soils are likely to be found where there is a very poor cover of low yielding tea and where there is much exposure of bare soil. The organic matter content will be low and there will be little or no microbial activity; in fact the more exposed areas are likely to be sterile as the result of insolation. The soil will tend to pack down hard to a considerable depth and both aeration and drainage will be very poor, leading to much run-off and erosion.

In such soils regular deep forking in showery weather with the incorporation of as much organic material as possible behind the fork can obviously do nothing but good, since all the desirable characters of the soil will tend to be improved thereby. However, much more than forking needs to be done if any permanent improvement is to be effected, but such recommendations are outside the scope of this article.

To sum up therefore it would seem that in soils with a high level of fertility deep forking does more harm than good, but that in soils with a lower level of fertility, in areas where there has been packing of the surface, and in areas subject to prolonged droughts, deep forking when wisely carried out, is likely to be beneficial. The category into which any particular estate field happens to fall must, however, be left to the judgment of the individual superintendent, since it would clearly be quite impossible for the Institute to attempt to assess soil conditions throughout Ceylon's whole tea area. As a guide it is probably safe to assume that no old field which does not develop a complete cover of tea during the course of the pruning cycle, and which is incapable of giving yields in excess of 1,000 pounds per acre per annum, can be expected to have a highly fertile soil entitling it to be placed in category 1.

Deep forking either during or just before a period of drought is expected must always be considered harmful in all types of soils.

REFERENCES

(1) Paterson, H. C. (1950)—Root disturbance with special reference to tea cultivation. Tea Quarterly, 21 (1), pp. 23-27.

(2) Tolhurst, J. A. H. (1956)—Ideas on the experimental replanting of tea. Tea Quarterly, 27 (3), pp. 60-66.

(3) Portsmouth, G. B. (1953)—The principles of bush management. Tea Quarterly, 24 (1 and 2), p. 19.

NOTES ON SOIL pH

J. A. H. Tolhurst

An explanation of the term "pH".—In the past year or two, the Institute has been emphasising the need to pay attention to the pH value of the soil, for various reasons, and superintendents have been showing an increasing interest in this factor. Naturally we have had queries as to the meaning of "pH", but it was usually possible to explain it away as being a means of expressing active acidity. This is perfectly true, but it does not go far enough to answer the direct question which has been put to us—"what is the meaning of the little 'p' and the big 'H'?"

We have been asked to explain this specific point, and since "pH" is a highly technical concept we shall have no hesitation in being technical.

Acidity is due to hydrogen atoms in a certain state of activity, and the greater the concentration of these atoms the higher the acidity. By the nature of things, the concentration of active hydrogen atoms occurring in, say, soil is extremely minute, and if expressed by everyday notation the result would be a cumbersome fraction, and mistakes would arise when referring to soil acidity in everyday matters, such as estate reports.

Scientists, who have no love for inefficient time-wasters, found the conventional methods of expression too clumsy for their purposes, and a mathematical dodge was adopted to simplify discussions on acidity. When this is applied, the results come out as manageable numbers, 4.5, 5.2, and so on. Since hydrogen is referred to scientifically as H, this part of the formula is obvious enough, and as we are now dealing with a juggled version of the true concentration of H it is necessary to have a reminder of the fact—hence the little "p".

We are, in effect, working in a shorthand code whenever we speak of pH values. "p" denotes the code, "H" defines the subject matter, active hydrogen atoms, and the figures attached designate the point on the scale from which we can work out the concentration of these active, acid producing atoms.

In the pursuit of convenience one complication has arisen. The *greater* the acidity the *smaller* the pH number. In practice this is the point to remember, but the foregoing technicalities were needed to show that this seeming anomaly is preferable to more unwieldy straight-forwardness. A further unexpected point is the relation between the pH numbers themselves, and a table will perhaps serve as a summary and a reference:

pH number, or value	*Acidity*
7.0	Neutral
6.0	Acid
5.0	10 times as acid as pH 6.0
4.0	10 times as acid as pH 5.0 and 100 times as acid as pH 6.0

A difference of 1.0 *e.g.* 5.1 – 4.1 or 5.8 – 4.8 means a difference of ten times in acidity.

A difference of 2.0, *e.g.* 6.2 – 4.2 or 5.9 – 3.9 means a difference of one hundred times in acidity.

In tea growing circles we refer to soils above about pH 6.2 as "alkaline", and although this is not correct the custom need not be abolished as long as we remember that true alkalinity does not start until the pH value is above 7.0. Acidity is expressed by numbers from 7.0 to zero; alkalinity from 7.0 to 14.0.

It is hoped that this very brief note will add to the general knowledge concerning pH numbers, and that we have avoided the usual pitfall in translating technicalities into everyday language, namely of leaving everyone in greater confusion than before.

Soil pH in tea nurseries.—Young tea, whether as seedlings or as vegetatively propagated cuttings, *i.e.* V.P., is very susceptible to poor growth on a soil which is insufficiently acid. From our experience of some thousands of advisory analyses we can now give a guide to the upper limit of soil pH for nurseries.

For seedlings the pH should be below 6.0.

For V.P. cuttings the pH should be below 5.6.

The difference between seedling and V.P. is interesting; although we can not explain it there is no doubt that V.P. is much more rapidly affected by a too high soil pH than is seedling tea.

Evidence of the adverse effect of too low a soil pH, that is, too great an acidity, is still so scanty that we do not issue any advice on that aspect.

The upper pH limits quoted above refer to well drained soil, and it is well known that even a slight waterlogging in tea nurseries can have the same effect as raising the pH slightly. Thus, if a soil with a pH value a little below the upper limit, say 5.8, for a bed of seedlings, is then waterlogged, the seedlings will probably behave as though the soil pH had been over 6.0. It is, unfortunately, necessary to emphasise that over-watering and poor drainage are in themselves bad for nurseries.

The water which is used on nurseries may itself have a pH of 6.0 to 7.0, but as long as the soil is sufficiently acid and well drained the high pH of the water will not cause damage. If there should be a harder layer at a few inches depth in the beds, or a layer of compost, either of which may hold up large quantities of water, the effect of high pH of the water may be harmful. In any event, such layers will cause trouble on their own account.

Too high a pH in nursery beds can be corrected very readily *before* they are planted up, but not *after*. Once plants have started to suffer they can only be saved by replanting into more acid soil, which is at best a very costly process. The Tea Research Institute has always offered to test nursery soils for their pH value and the presence of parasitic eelworm species, and perhaps this valuable advisory service has not had the publicity it deserves. Testing a soil before using it in nurseries allows any fault in pH or eelworm to be corrected, and there should really be no reason for a nursery to fail in either of these respects.

Soil samples should be taken from the full depth of the bed, or from the whole bulk of soil which will eventually go into baskets.

There is only one practicable method of lowering the soil pH, and the only advice which the Institute gives is as follows:—

(1) Broadcast sulphur at the recommended rate, see below, and mix it as thoroughly as possible to the full depth of the bed, or throughout the bulk of soil for baskets.

(2) Keep the soil well watered and if necessary well aerated. The reaction is a biological one and the bacteria act more rapidly with a plentiful supply of air and water.

(3) Leave the soil for two months before planting.

If the above instructions have been carried out there should be no danger to plants after this period, and the soil will remain acid indefinitely.

RATE OF APPLICATION.—This is not easy to define rigidly, as different soils will respond in different degree. Also, if the top few inches of soil, only, have a high pH, then less sulphur will be required than if the top foot of soil is too alkaline. Roughly, between 1 and 3 *ounces* per square yard may be taken as the normal application. This is approximately between one third of a *pound* and one *pound* of sulphur per cubic yard of bulked soil.

WARNING.—Sulphur should never be applied to a nursery while there are plants growing.

If a soil with a very high pH, say over 7.0, is met with, the Institute's advice should be sought, as it may not be worth while to try to reduce the pH.

MISCELLANEOUS NOTES

THE DISPERSAL OF *DRYMARIA CORDATA* SEEDS BY GROUND—FEEDING BIRDS

W. W. A. Phillips

(Tonacombe Estate, Namunukula.)

On the morning of 24th May, while in one of the top fields of Tonacombe estate, adjoining extensive hill-patanas (alt. 4,500 ft. approx.), I observed a common Indian pipit (*Anthus richardi malayensis*) feeding a full grown juvenile. The youngster was standing on a low stone in young tea and could be well observed, with the aid of field-glasses, from a distance of under 25 yards. The parent approached through the tea and, after feeding the youngster on a small grasshopper, turned its back so that the rump and tail could be well seen.

On the rump was a single small green seed and attached to the tips of the tail feathers were several more. Although there is very little Drymaria on this estate, I do not think that there is much doubt that the seeds were those of *Drymaria cordata* clinging to the bird's feathers. Presumably they had been picked up as the pipit had run through or brushed against a Drymaria plant, during its search for insects.

Although it has always been well known that the seeds of *Drymaria cordata* are widely distributed, through adhering to the fur and hairs of animals which have brushed against the plant, I have not previously observed the seeds being spread by a ground-feeding bird.

IMPROVED FUNGICIDES

J. A. H. Tolhurst and B. N. Webster

As a result of extensive trials conducted over the past two years it has been shown that:—

(*a*) a specially formulated water dispersible copper fungicide containing only 12 per cent. of copper is capable of giving adequate control of blister blight when used at the normal frequency and application rate of 6 ounces of fungicide per acre;

(*b*) a specially formulated dust containing only 1 per cent. of copper is capable of giving adequate control of blister blight when used at the normal frequency and application rate of 5 pounds of dust per acre.

Both these developments will lead to a considerable reduction in the copper content of the made teas, even when application is as close as two days before plucking.

Full details of these important developments in the science of crop protection will be published later.

REVIEWS

"Practical Plant Protection" by E. Holmes. Pp. XII + 252, with 4 plates. London, Constable & Co., Ltd., 1955, 15/-.

Modern plant protection is perhaps one of the worst "vicious circles" encountered in the whole field of agriculture. This results from the constant necessity of finding new formulations, partly to keep pace with the rapid acquisition of resistance achieved by some pathogens, and partly to find alternative and more selective toxic agents to avoid dangerous side effects resulting from long use of less selective agents. The result of this constant change is that the average grower finds himself confronted with a bewildering and ever increasing list of chemicals, compounded as insecticides, fungicides, fumigants, seed dressings and so on.

Dr. Holmes's book has been produced to meet the needs of the grower and consequently is clearly and concisely written, in language easily understandable by the layman.

Chapters I-VI deal with the broad field of plant protection, the methods in use, available products and their formulations, and a very instructive discourse on the purpose, use and limitations of the British approved scheme is included. The next six chapters deal with the occurrence and control of the pests, and then the diseases, of the majority of crops grown on a commercial basis in the British Isles. The use of more illustrations in this section would no doubt assist the grower further in the recognition of the pests and diseases described, but in a book essentially aimed at control it is possible that such additions would be superfluous. Now-a-days, with the aid of coloured wall charts and the books included by Dr. Holmes in his excellent bibliography there is no excuse for an intelligent grower being unable to identify any pest or disease infesting his crops.

Following four chapters on weed and scrub control, virus problems, eelworms and deficiency diseases each receive a chapter, and, following discussion of miscellaneous pests and the interaction of chemical control upon beneficial organisms, the last three chapters are devoted to practical application and handling of chemical products.

Thus, it will be seen that the layout is ideally suited to use by the lay reader, who wishes to know at a glance what to do. The book is not, however, a mere compendium of instructions—on the contrary it is surprising that so much description of the life histories and habits of the pests and disease organisms selected could have been included. Further discussion on such matters as the DDT application/predator complex in fruit spraying gives all the information required by the grower without ever becoming too technical.

No attempt is made at boosting any particular product, and even advertising by means of the illustrations, now a common and unfortunate practice, has been kept to a minimum.

If such a book could be produced for the tropical planter it would meet a considerable demand, and the present work with replacement of Chapters VI and VII, and rewriting of Chapters XV, XVIII and XIX, would seem to be admirably suited to this purpose.

B. N. W.

"Johnson's Note Book for Tea Planters" by R. J. Johnson. Third enlarged edition. Pp. XV + 481 + IX, numerous illustrations. 1955, Rs. 20/–.

In response to various requests and increasing demand for his "Note Book for Tea Planters" the author has presented this third and much enlarged edition. The work has been divided into four parts, the first two, on planting and manufacture, occupying the main portion. Part III gives a brief description of tasting, marketing and propaganda. Part IV of the last edition has been replaced by a new part on estate book-keeping and accountancy, which presents the subject in simple form and should be useful to "creepers".

In Part I the author takes us through all the stages of tea planting, beginning with the opening of land and ending with pests and diseases and their control. The author, who is primarily a compiler, has drawn freely on established authorities, and the book contains much useful information of a general nature.

The problem of erosion and soil conservation has rightly been given prominence, but the emphasis on the means of control has perhaps been misplaced. There is a 68 page chapter on shade, green manures, ground covers and wind belts. Guatemala grass and mana grass receive a 3 page chapter headed "mulching", in which no mention is made of their value as soil builders. Nowhere is the importance of a good cover of tea mentioned as the best antidote to erosion. With a good cover of tea, cover crops and green manures in tea should not be necessary. There is evidence to show that the burying of green manures in a fresh state may definitely be deleterious (except in certain very specific circumstances) and cover crops should be used to protect banks, etc. and on land not required for tea.

Chapters X, XI and XII deal with the principles of bringing young plants into bearing, pruning, tipping and plucking. The various methods are set out clearly and fully (except for slope pruning), but where the author has attempted to give the reasons for any method by an explanation of the physiological processes within the tea bush, startling errors appear, the most remarkable being that the bush's starch reserves are stored in the older tissues of the wood.

The book contains a number of statements for which there is little or no scientific support, and a number of errors. Some of these statements may be dangerous and the most important of them are listed at the end of this review.

It is disappointing to note that the author has not taken the opportunity to bring the subject matter up to date. A most glaring example is the omission of any reference in part II to continuous rolling, which under certain conditions has considerable advantages over the normal method. Neither is any reference made in part I to new developments in spraying equipment for blister blight control.

The enlargement of the book has unfortunately led to many scattered allusions to the same subject and in some cases to needless repetition. A system of sectional numbering to allow of cross-references would have been helpful, and the additional editing, which this would have entailed, might have eliminated many of the typographical errors.

Comments and Corrections

CHAPTER III, pp. 10-12.	It is not true that forest soils are invariably the best. A good patna soil has a far better tilth and structure than the best forest soil, and the top soil is often of greater depth.

CHAPTER V, pp. 29-30. The recommendation to fill holes or trenches with green manure a fortnight before planting is dangerous. Fresh green material may take months to decompose, and during this period will compete with the young tea. Only well rotted organic matter should be used, mixed with soil and well rammed down.

CHAPTER VII, p. 43. We are not aware in Ceylon of any evidence that high shade is beneficial in lessening tortrix attack.

CHAPTER VIII, p. 56. The statement that ring-barking of old *Albizzia* trees is viewed with disfavour is not true. We consider that ring-barking does minimise the risk of certain root diseases and we recommend the practice wherever possible.

CHAPTER VIII, p. 114. The recommendation to use only the best jungle soil for filling baskets should be taken with reserve. There is a possibility of introducing root diseases if such soil is used.

CHAPTER VIII, p. 115. The addition of coir dust to the mixture for soil blocks is primarily to prevent the blocks getting compact. It will not prevent "bitten-off". In fact coir dust has a high pH reaction.

CHAPTER VIII, 131. Raising of nursery beds may result in cuttings on the edges suffering from drying out in dry weather. However, over-watering is a common fault in nursery management and on raised beds the edge plants will suffer least from this trouble.

CHAPTER X, p. 148. We do not advocate centering of 2 year old seedlings, but recommend thumb-nail pruning or pegging down.

CHAPTER XVI, p. 224. We know of no evidence to justify the statement fixing an upper limit of 30 lbs. of phosphoric acid per acre in manurial applications. The amount of any nutrient which can be economically applied depends on crop yield and soil conditions.

CHAPTER XVII, p. 243. Lime obtained by treating coral in any way is not equivalent to dolomite. There is little magnesium in coral and it would be uneconomic to use this source for treatment of magnesium deficiency. Local burnt coral lime is sometimes sold in a very caustic state, and can cause serious burns. Crushed dolomite rock is quite harmless.

CHAPTER XX, p. 312. "Bitten-off" disease is not caused by the fungus *Sphaerostilbe repens* in the nursery. The cause is unsuitable soil acidity, as is correctly stated in the description on the plate.

CHAPTER XX, p. 318. By far the most serious of the nettle grubs is *Natada nararia*. This pest is at times naturally controlled by a virus "wilt". When spraying is necessary to effect control a soap solution is recommended in preference to D.D.T.

CHAPTER XX, pp. 319-321. The tea tortrix caterpillar is no longer an important pest in Ceylon, being controlled by the *Macrocentrus* wasp, imported from Java in 1935.

CHAPTER XX, p. 322. Bushes attacked by *Calotermes militaris* cannot be saved by clearing out the cavities and treating them with a solution of creosote or some other wood preserving liquid.

J. V. H.

DROUGHT

T. Visser and F. H. Kehl

This article was first published as a circular in July of this year and is reproduced again here as a result of numerous requests from planters.

The very severe drought experienced early in the year caused widespread concern among tea planters, and prompted the Board of Control to instruct the Tea Research Institute to publish its views and recommendations for the prevention or alleviation of the severe effects of drought.

In issuing this circular it is emphasised that little research work has been carried out on droughts, and in making the following recommendations reliance has had to be placed on general principles rather than on experimental data.

Tea plants, like most other plants, lose water through evaporation mainly through their leaves. The amount lost in this way is enormous; under normal conditions of growth, provided the tea can continue to obtain all the water needed, this loss has been estimated to be equivalent to 3-4 inches of rain per month. This process of evaporation is known as "transpiration". Transpiration is necessary for the plant and causes normally no injury, but when there is a lack of water in the soil and the atmosphere is dry a continual loss may result in a set-back of a temporary or permanent nature to the tea.

How much water a plant will lose through transpiration will depend on its leaf area and prevailing atmospheric conditions such as light, temperature and wind.

If transpiration is reduced or enhanced by some factor the amount of water required by the roots will also be decreased or increased. In the latter case, if water is not obtainable to the roots in sufficient quantities, the tea will begin to wilt. Accordingly, the problem of successfully weathering a drought is one of finding a balance so that the loss of water through transpiration or directly from the soil is reduced to a minimum.

The tea bush in its natural habitat grows under shade. It is a shade-loving plant and its leaves are not provided with any special mechanism, like *e.g.* the xerophytes, to restrict water loss during a spell of dry weather. Thus, removal of overhead shade during drought would very markedly increase transpiration both due to the increased light intensity and to the increased temperature of the leaves. The temperature of the leaves exposed to direct sunshine may increase as much as 10°C above that of the surrounding air, resulting in sun scorch. Last but not least a considerable reduction in the existing shade would also lead to more wind, which factor alone may greatly increase the transpiration rate of the tea bushes. Consequently, it can be assumed that the reduction in water loss, as brought about by the presence of sufficient overhead shade, will far outweigh the amount of water lost by competition from the shade. Naturally, much will depend on soil depth, number, size and type of shade trees employed. A shallow soil and the presence of shade trees which have no adaptability against drought conditions like dadaps and Gliricidias, will be detrimental to the tea plants during a dry period. On the other hand, on a soil which allows deep rooting and which is planted with shade trees able to

withstand drought, *e.g.* species of *Albizzia*, competition for water may be much less to be feared, since the shade trees are likely to draw their requirements from levels inaccessible to tea roots.

The general outlines given above may be interpreted into the following short term measures against drought:—

(1) **Prevention of Direct Evaporation of Water from the Soil Surface.**—This is of special importance in all cases where the tea bushes themselves do not provide a sufficient soil cover.

(i) Thatching with Guatemala or Mana grass, or any other material available, will give a good soil cover. Thatching will also considerably reduce any direct heating of the soil. Every 30 rows or so, about six rows must be left unthatched to serve as fire breaks.

(ii) No cultivation of any sort should be undertaken at the beginning of or during, a dry period; it will only increase the rate of evaporation of water from the soil.

(2) **Reduction of the Competition for Water with Bush Manures and Shade Trees.**—(i) Bush green manures like Crotalaria, Tephrosia and ground covers like Stylosanthes, etc. are likely to compete for water in the same soil levels. Accordingly, these should be cut back at the very commencement of a drought, and the loppings used as a thatch.

(ii) It is also strongly advisable to partially remove the foliage of the shade trees by lopping, *e.g.* the alternating branches, this should be done particularly if the medium shade consists of dadaps or Gliricidias. In general one should reduce the transpiration surface of the shade to such an extent that still enough cover is left to protect the tea from direct sunshine (see (3) (i)).

(3) **Reduction of Transpiration of the Tea itself.**—(i) This can be done indirectly by keeping as much shade as is essential to prevent exposure of the tea to the sun (see (2) (ii)). In this way extra water loss due to increased temperature and light intensity will be avoided.

(ii) Water loss by the tea bushes can be also directly reduced by reducing its own leaf area. Therefore, if a drought sets in, plucking should be continued in order to remove any flush produced. Eventually, should the drought persevere, as a last resort pruning might be undertaken if the general health of the bushes is good and starch reserves adequate. This may afford an effective, though drastic, means of enabling the bushes to survive a water shortage. The removal of about 50 percent . of the leaf area should be the aim. Young plants must be stripped of their leaves, or cut back, in any case.

The following long term measures to reduce the consequences of drought must be considered:—

(1) **Shade Trees.**—It is important that high and medium shade trees be planted on a rotational system, (see *Tea Quarterly*, Vol. XXIV, Part 3, September 1953, pages 90-93), in order to ensure that fields will not be exposed by the removal of trees which have survived their period of usefulness. They should not be allowed to grow too big. Preferably trees should be chosen which can adapt themselves to dry conditions, such as Grevillea and species of *Acacia* and *Albizzia*.

(2) **Drainage.**—Good drainage is an additional help in retaining soil moisture (and in preventing soil erosion). Every effort should be made to adopt a system

that will be able to trap the maximum amount of rain water. Lateral drains should be spaced at a distance of about 20 to 25 feet and aligned at a gradient of about 1 in 120. Reverse slope drains appear to be the most suitable as the water holding capacity of such drains is much more than that of silt pits.

(3) **Organic Matter.**—An increase in the organic matter content of the soil should be aimed at by thatching or by spreading of compost, tea refuse, cattle manure or green material on the surface. Soil should not be disturbed by forking during, or just before a drought may be expected. Organic matter improves the texture of the soil and its water capacity and indirectly increases the soil depth in which feeding roots can develop.

(4) **New Planting.**—When new planting of tea is carried out, wide holes or trenches at least 18 inches deep should be cut before putting out plants in clearings, or as supplies. Such holes or trenches will give the plants a better chance of developing extensive root systems. Such plants would be better able to survive a drought.

(5) **Wind Belts.**—The planting of wind belts in order to reduce the effect of hot winds is highly advisable. In order to be really effective wind belts should be planted on a district scale, especially in those areas where large areas of patna exist.

(6) **Selection for Drought Resistance.**—In areas where droughts occur it is important to look for plants that appear to withstand dry conditions well.

MINUTES OF THE MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON, HELD AT THE OFFICES OF THE PLANTERS' ASSOCIATION OF CEYLON, COLOMBO, ON FRIDAY, 1ST JUNE, 1956, AT 2-30 P. M.

Present.—Mr. F. Amarasuriya, (Chairman), Senators T. Amarasuriya, O.B.E., (Chairman, Planters' Association of Ceylon) and E. W. Kannangara, C.B.E., (Chairman, Low-Country Products Association), Mr. R. M. Macintyre, (Chairman, Agency Section, Planters' Association of Ceylon), Dr. A. W. R. Joachim, O.B.E., (Director of Agriculture), Messrs. R. C. Scott, C.B.E., G. J. Harris, J. L. D. Peiris, V. G. W. Ratnayaka, M.B.E., W. H. W. Coultas, B. Amarasuriya, A. Divitotawela and G. B. Portsmouth (Director and Secretary).

Also.—Messrs. G. A. D. Kehl and J. V. Harbord (T.R.I.).

Letters regretting inability to attend were received from Messrs. D. C. L. Amarasinghe, A. D. McLeod, G. K. Newton and N. B. Parker.

1. Notice convening the meeting was read.

2. **Minutes of the Board Meeting held on 28th March, 1956**

The minutes were confirmed.

3. **Membership of the Board and Committees**

It was reported that:—

(i) Mr. A. D. McLeod had been succeeded as Chairman of the Agency Section of the Planters' Association by Mr. R. M. Macintyre, who thus became an ex-officio member of the Board as from June 1st, 1956.

(ii) The Agency Section of the Planters' Association had appointed Mr. A. D. McLeod to fill Mr. Macintyre's seat as a nominated member. During Mr. McLeod's absence on leave Mr. W. H. Gourlay would act for him.

(iii) Consequent upon Mr. Amarasuriya's assumption of the Chairmanship, his place as an ordinary member of the Standing Committee required filling. Mr. Macintyre was nominated to this vacancy. Proposed Mr. Ratnayaka. Seconded Mr. Divitotawela.

(iv) Likewise Mr. Amarasuriya's ordinary seat on the Building Committee was vacant. Mr. Harris was elected to his seat. Proposed Mr. Macintyre. Seconded Mr. B. Amarasuriya.

4. **Minutes of the Small Holdings Committee Meeting held on 1st March, 1956**

Audit Fees.—Mr. Kehl reported that a fixed fee had not yet been agreed. It was hoped to settle the matter after the completion of the current audit. The

difficulty was that the auditors' expenses were not easily calculable in advance. It was agreed that Mr. Kehl should follow up a suggestion by Mr. Macintyre that as much of the audit as possible should be done in Colombo at the auditors' offices. It was thought that in this way expenses might be reduced.

The minutes were formally approved.

5. Minutes of the Standing Committee Meeting held on 11th May, 1956

(i) Water Supply Scheme.—It was reported that all tender and contract documents and the specifications and bills of quantity were completed. The first of three insertions calling for tenders would appear in the Daily News and Times of Ceylon the next day.

(ii) Junior Staff Association Trade Union and Whitley Committee.—The Board agreed to recognise the Junior Staff Association as the proper body to represent the Junior Staff in matters concerning conditions of service, etc., provided that the rules of the Association remained the same as they were before the formation of the Trade Union and Whitley Committee.

(iii) Colombo Plan Exhibition, 1957.—It was reported that the Institute had been unable to recover from Government any of the expenditure incurred on the Royal Agriculture and Food Exhibition held in 1956.

(iv) Buddha Jayanthi Festival.—The Board endorsed the action of the Standing Committee in closing the Institute for the two days of the Wesak Festival (23rd and 24th May).

In formally proposing the acceptance of the Standing Committee minutes, Mr. Scott endorsed the recommendation for increasing the office staff.

The minutes were approved.

6. Minutes of the Experimental and Estate Committee Meeting held on 12th May, 1956

Referring to the recent prolonged drought, Mr. Coultas asked for the publication of the Institute's views and recommendations for alleviating the effects of drought. It was agreed to publish a duplicated circular as early as possible.

Mr. Ratnayaka drew attention to the need for investigating problems of specific importance in connection with tea manufacture in the low-country.

The minutes were approved.

7. Resolution by Dr. Joachim

Dr. Joachim moved the following resolution, which had been previously circulated to members:—

> "In order to provide for continuity of research in the Institute, a suitably-qualified Ceylonese graduate in Science or Agriculture should be attached to each of the Research Officers of the Institute as an understudy and Research Assistant to the latter. If, in due course, these Research Assistants should prove themselves to be efficient and capable research workers and are otherwise suitable, they should be given opportunities for promotion to the substantive post as and when these fall vacant."

Senator Kannangara seconded the resolution. Mr. Scott pointed out that the substance of the resolution had already been accepted by the Board in principle. After some discussion it was agreed that a form of cadet training scheme should be started.

8. **Any Other Business**

Building Committee.—Mr. Peiris reported that all plans and documents were completed, and that tenders for both the senior and junior staff houses would be called for within a few days.

The meeting closed at 4-45 p.m. with a vote of thanks to the Chair.

Sgd. G. B. PORTSMOUTH,
Secretary.

Tea Research Institute of Ceylon,
St. Coombs,
Talawakelle.

Printed for the TEA RESEARCH INSTITUTE OF CEYLON, *St. Coombs, Talawakelle, by* H. W. CAVE & CO., LTD., *Fort, Colombo.*